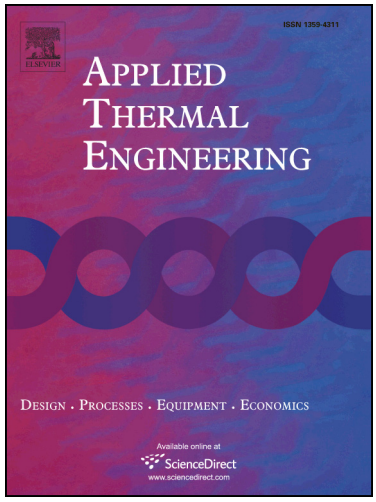

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Abstract

Fumed silica based thermal insulating composite is a novel nanoporous material with excellent thermal insulating performance. However, shrinkage at higher temperatures (>800 °C) is a great challenge in application. In this work, fumed silica based thermal insulating composite was prepared by a dry molding method and fumed alumina was introduced to improve high-temperature thermal stability of the composite. The result shows volume shrinkage can decrease from 18.49% to 2.61% at 1000 °C when 20 wt% fumed alumina is added as an inhibitor. Thermal shrinkage inhibition mechanism was investigated by molecular dynamics simulation. The models of fumed silica and fumed alumina super cells were built and mean square displacement (MSD) was calculated. The result indicates MSD of fumed silica is 0.198 $Å^2$ at 1000 °C while that of fumed alumina is only 0.0151 $Å^2$. In addition, thermal insulating property was comprehensively studied and the effect of fumed alumina on thermal conductivity was analyzed. The result shows this composite has excellent thermal insulating performance with thermal conductivity of 0.052 W/m•K at 800 °C and the introduction of fumed alumina has almost no effect on thermal insulating property. This work can provide theoretical guidelines for the choice of shrinkage inhibitor.

Keywords

Nanoporous material; Thermal insulation; Fumed alumina; Molecular dynamics simulation

1. Introduction

There has been a large increase of world energy consumption over the past 40 years.

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